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(54) **RANGE CHANGE DEVICE**

(71) Applicant: **Mitsubishi Electric Corporation**, Tokyo (JP)

(72) Inventors: **Takuya Uryu**, Tokyo (JP); **Kazuhisa Kurita**, Tokyo (JP); **Yoshiki Saiki**, Tokyo (JP); **Chiaki Sugano**, Tokyo (JP); **Masayuki Aota**, Tokyo (JP)

(73) Assignee: **Mitsubishi Electric Corporation**, Tokyo (JP)

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(51) **Int. Cl.**

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CPC ..... ***F16H 61/32*** (2013.01); ***F16H 37/065*** (2013.01); ***F16H 61/12*** (2013.01); ***F16H 63/3458*** (2013.01); *F16H 2061/122* (2013.01); *F16H 2061/1292* (2013.01); *F16H 2061/326* (2013.01)

(58) **Field of Classification Search**

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See application file for complete search history.

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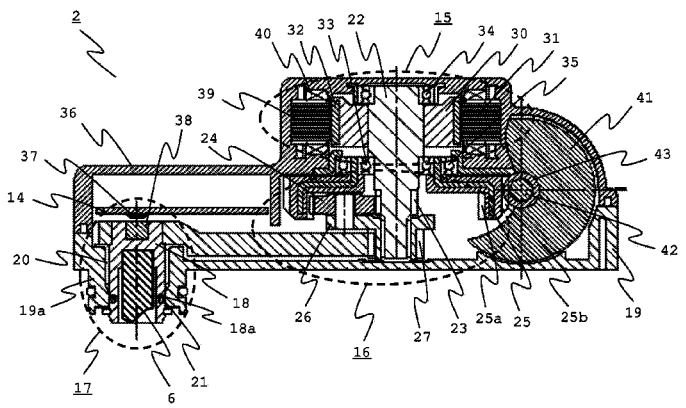
*Primary Examiner* — Sherry Estremsky
*Assistant Examiner* — Lillian Nguyen
(74) *Attorney, Agent, or Firm* — Sughrue Mion, PLLC

(57) **ABSTRACT**

Provided is a range change device which includes a main motor and an auxiliary motor, a sun gear which is joined to a motor shaft of the main motor, an auxiliary gear which is joined to a motor shaft of the auxiliary motor, a plurality of planetary gears which are engaged with the sun gear, an annular gear in which internal teeth engaged with the planetary gears and external teeth engaged with the auxiliary gear are formed, a carrier which supports the planetary gears in a state where the carrier allows the planetary gears to rotate and revolve and is rotatable on an external circumference of the motor shaft, a small gear which is mounted on the carrier and rotates about an axis of the motor shaft, and a large gear which is engaged with the small gear.

**4 Claims, 4 Drawing Sheets**



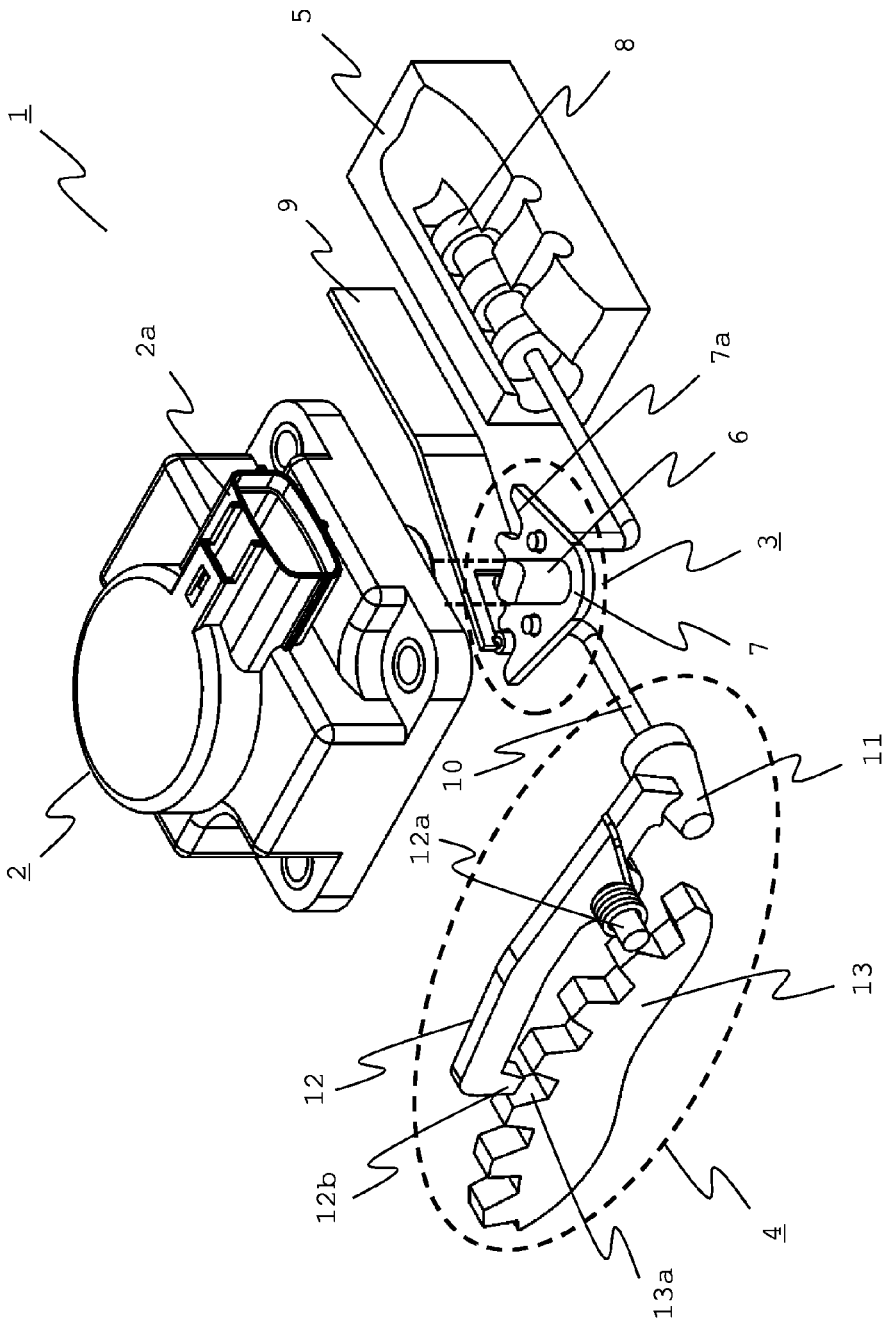



FIG. 1

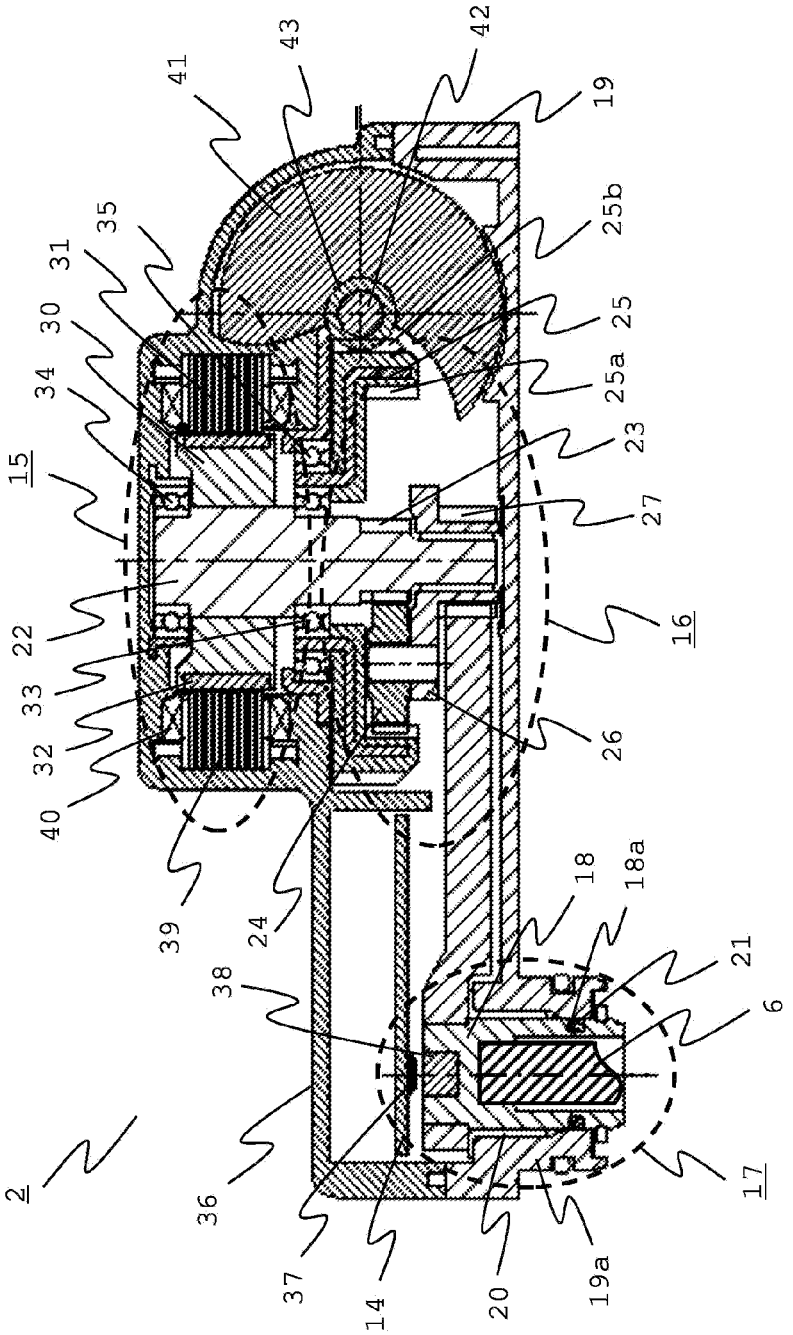

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FIG. 2

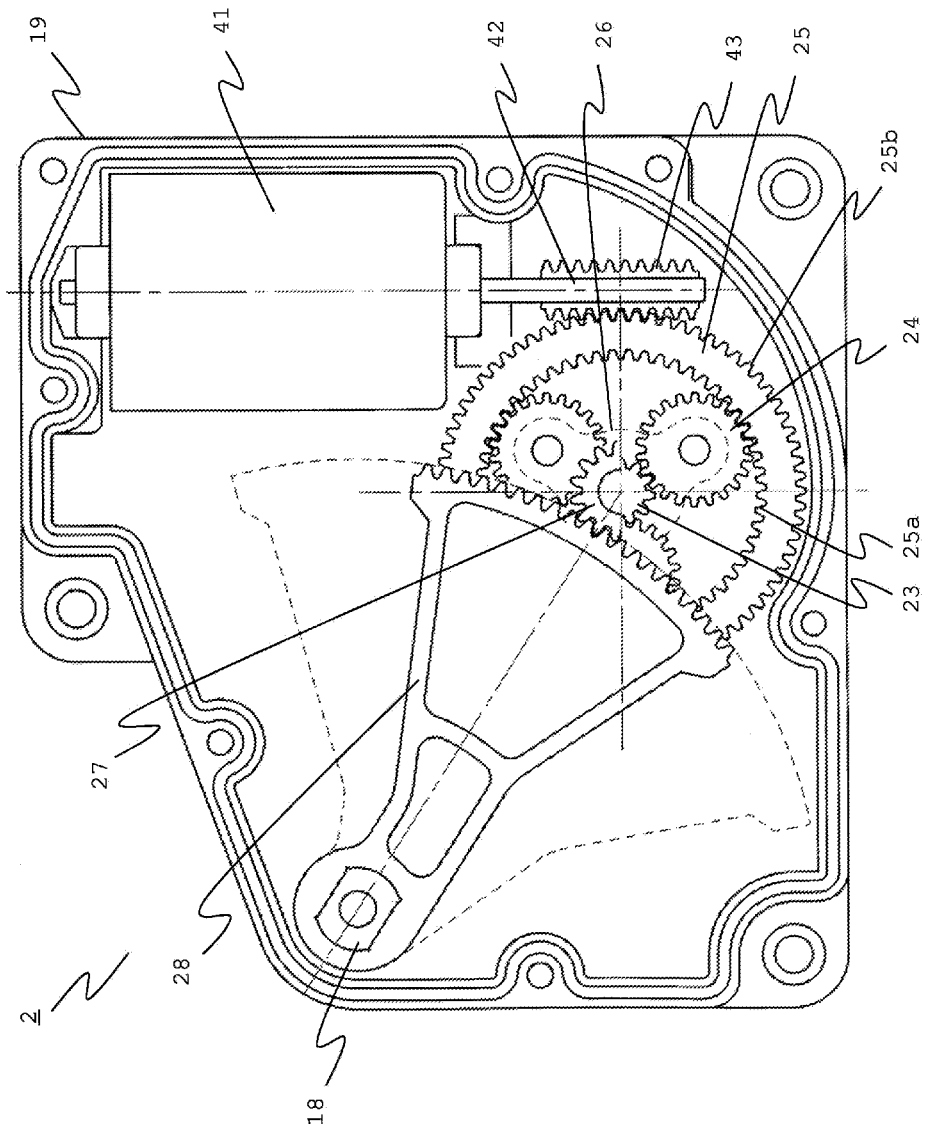


FIG.3

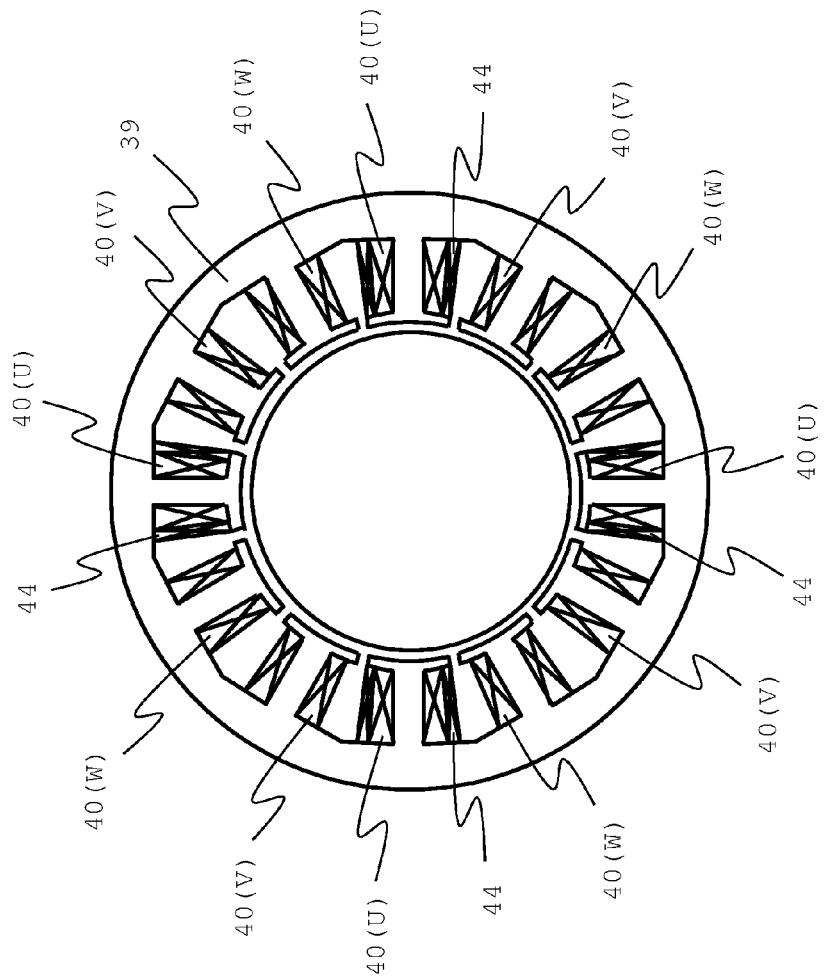
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FIG. 4

# RANGE CHANGE DEVICE

## BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a range change device of a shift-by-wire system which changes a shift range of an automatic transmission of a vehicle through an electric signal.

2. Description of the Related Art

In recent years, a shift-by-wire system which changes a shift range of an automatic transmission of a vehicle through an electric signal, in accordance with instructions of a driver of the vehicle, has been applied to a vehicle control. It is necessary for a vehicle to be reliably stopped and towed even when failure occurs due to some factor. In the case of a vehicle of the related art, in which a shift-by-wire system is not used, a shift range of an automatic transmission is changed to a P range or a parking brake is operated, in such a manner that the vehicle can be stopped. Furthermore, the shift range of the automatic transmission is changed from the P range to other ranges, in such a manner that it is also possible to easily perform towing of the vehicle.

However, in a case of a vehicle to which a shift-by-wire system is applied, a shift range of an automatic transmission is electrically changed. Accordingly, when failure, such as exhaustion of a battery or disconnection in wiring, occurs in a power source or a power supply system, it is difficult to change the shift range of the automatic transmission. Thus, even the vehicle including the shift-by-wire system requires a range change device which can change the shift range of the automatic transmission when failure occurs in the vehicle due to some factor.

In a shift-by-wire device (in other words, an SBW device) disclosed in JP-2008-180250A, a capacitor is provided to store power supplied to range control means, as a method of changing a shift range of an automatic transmission when failure occurs in a power supply system. Thus, even when failure occurs in a battery or a power supply system, an actuator of the SBW device can allow the shift range of the automatic transmission to be changed to the "P range" at least once, using the power stored in the capacitor. As a result, the vehicle is safely and reliably stopped.

Furthermore, a lever is operated, in such a manner that the shift range of the automatic transmission is manually released from a "P range". As a result, the vehicle in a parked state can be easily moved by, for example, traction.

The SBW device of the related art is a countermeasure in which it is assumed that, when power is not supplied due to, for example, failure in the power supply system, the actuator changes the shift range to the P range using power stored in the capacitor. However, when failure occurs due to a voltage reduction in the power source, the actuator of the SBW device of the related art does not normally operate, and thus there is a problem in that the shift range cannot be changed.

## SUMMARY OF THE INVENTION

The present invention is made to solve the problem described above. An object of the present invention is to provide a range change device which can change a shift range even when a voltage reduction resulting in an abnormal operation of an actuator occurs.

According to an aspect of the invention, there is provided a range change device which includes a main motor and an auxiliary motor, a sun gear which is joined to a motor shaft of the main motor, an auxiliary gear which is joined to a motor shaft of the auxiliary motor, a plurality of planetary gears which are engaged with the sun gear and are arranged on a circumference of the sun gear at equal intervals, an annular gear in which internal teeth engaged with the planetary gears and external teeth engaged with the auxiliary gear are formed, a carrier which supports the planetary gears in a state where the carrier allows the planetary gears to rotate and revolve and is held in a state where the carrier is rotationally slid on an external circumference of the motor shaft of the main motor, a small gear which is mounted on the carrier on a surface opposite to a surface on which the planetary gears are mounted and rotates about an axis of the motor shaft of the main motor, and a large gear which is engaged with the small gear. Furthermore, a shift range of an automatic transmission is changed by rotation of the large gear.



According to the range change device of the present invention, an auxiliary motor is mounted to perform a shift-range change at the time of a reduction in supply voltage. Thus, the following effect can be obtained. First, even when supply voltage is reduced, the shift range can be changed by the auxiliary motor. In addition, when the supply voltage is recovered, the shift-range changing operation by the auxiliary motor can be switched to a normal shift-range changing operation by the main motor.

The foregoing and other objects, features, aspects and advantages of the present invention will become more apparent from the following detailed description of the present invention when taken in conjunction with the accompanying drawings.

## BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a perspective view illustrating a configuration of the entirety of a shift range changing system including a range change device according to an embodiment 1.

FIG. **2** is a lateral cross-sectional view of the range change device according to the embodiment 1.

FIG. **3** is a perspective plan view of the range change device according to the embodiment 1.

FIG. **4** is a view illustrating a configuration of a coil portion of a main motor in a range change device according to an embodiment 2.

## DETAILED DESCRIPTION OF THE INVENTION

Hereinafter, details of a range change device according to embodiments of the present invention will be described with reference to FIGS. **1** to **4**.

### Embodiment 1

FIG. **1** is a perspective view illustrating a configuration of the entirety of a shift range changing system including a range change device according to an embodiment 1, FIG. **2** is a lateral cross-sectional view of the range change device, and FIG. **3** is a perspective plan view of the range change device.

First, the configuration of the entirety of the shift range changing system including the range change device according to the embodiment 1 will be described with reference to FIG. **1**. A shift range changing system **1** is configured to have a range change device **2**, a detent mechanism **3**, a parking mechanism **4**, and a valve body **5**.

In this case, the range change device **2** is configured to be installed in, for example, an automatic transmission

mounted on a vehicle. Furthermore, the range change device **2** includes a connector **2***a* which receives a shift signal (in other words, an electric signal) from a shift lever (in other words, range selecting means) of which the position is selected by a driver of a vehicle. The range change device **2** drives to rotate a shift shaft **6** which is a drive target and is connected to an output shaft **18** described below, in accordance with the shift signal, in such a manner that the range change device **2** causes a detent plate **7** to rotate in a forward direction or a reverse direction. The detent plate **7** is mounted on the shift shaft **6** and has a substantially fan shape. A spool valve **8** is mounted on the detent plate **7**, in a state where the spool valve **8** is connected to the detent plate **7**. When the detent plate **7** rotates in accordance with the rotation of the shift shaft **6**, the spool valve **8** moving in conjunction with the detent plate **7** reciprocatively moves in the valve body **5**. Accordingly, an oil path in the valve body **5** is changed, in such a manner that a shift range is set to a predetermined shift range (P, R, N, or D).

In the detent plate **7**, a plurality of concave portions **7***a* are provided in a tip end portion having a substantially fan shape. The concave portions **7***a* respectively correspond to the range positions (P, R, N, and D) of the spool valve **8**. Furthermore, a detent spring **9** fixed to the valve body **5** functions as a plate spring and the tip end of the detent spring **9** is pressed to the concave portions **7***a*, in such a manner that the detent plate **7** is positioned and held.

Meanwhile, the parking mechanism **4** has a parking rod **10**, a conic portion **11**, a parking pawl **12**, and a parking gear **13**. The parking rod **10** is connected to the detent plate **7**. The conic portion **11** is provided in the tip end of the parking rod **10**. In the parking rod **10**, the position of the parking rod **10** is changed in accordance with rotational movement of the detent plate **7** in a forward direction or a reverse direction, in such a manner that the parking pawl **12** performs a seesaw movement in a vertical direction with a shaft **12***a* as a center via the conic portion **11** in the tip end of the parking rod **10**. A convex portion **12***b* of the parking pawl **12** is fitted to a concave portion **13***a* of the parking gear **13** or is separated from the concave portion **13***a*, in accordance with the movement, in such a manner that locking or unlocking of the parking mechanism **4** is operated. As a result, it is possible to prevent or allow rotation of a central output shaft of the parking gear **13** in an automatic transmission.

In the shift range changing system **1**, the shift shaft **6** moves in conjunction with the spool valve **8** via the detent plate **7**, as described above. Thus, a rotation angle of the shift shaft **6** is controlled, in such a manner that the position of the spool valve **8** is controlled. As a result, the shift range can be set to a predetermined shift range.

Next, details of the configuration and the operation of the range change device **2** which is a principal portion of the present invention will be described with reference to FIGS. **2** and **3**. In FIG. **2**, the range change device **2** includes a control substrate **14**, a main motor **15**, an auxiliary motor **41**, a speed reduction mechanism **16**, and a range changing portion **17**. The control substrate **14** generates a control signal in accordance with the shift signal from the shift lever. The main motor **15** is controlled in accordance with the control signal from the control substrate **14**. The speed reduction mechanism **16** is connected to the main motor **15**. The range changing portion **17** causes the shift shaft **6** connected to the speed reduction mechanism **16** to rotate, in such a manner that the range changing portion **17** performs a change in the shift range. Furthermore, the speed reduction mechanism **16** is also connected to the auxiliary motor **41**.

In this case, the output shaft **18** of the range changing portion **17** is rotationally held in a support cylinder portion **19***a* of a front body **19** constituting a housing of the range change device **2**, via a metal bearing **20** provided in the support cylinder portion **19***a*. In addition, a concave portion **18***a* is provided in a front-side outer circumferential portion of the output shaft **18**. The output shaft **18** is held in an air-tight state or a liquid-tight state with respect to the outside, through a sealing member **21** which is interposed between the concave portion **18***a* and the front body **19**.

The speed reduction mechanism **16** is configured to have a planetary gear speed reduction mechanism and a spur gear speed reduction mechanism. The speed reduction mechanism **16** has a sun gear **23**, a planetary gear **24**, and internal teeth **25***a*. The sun gear **23** is mounted on a motor shaft **22** which rotates. The planetary gear **24** is engaged with the sun gear **23**. The internal teeth **25***a* are engaged with the planetary gear **24**. The speed reduction mechanism **16** further includes an annular gear **25**, a carrier **26**, a small gear **27**, and a large gear **28**. The annular gear **25** has external teeth **25***b* engaged with an auxiliary gear **43** which is mounted on a motor shaft **42** of the auxiliary motor **41**. The carrier **26** supports the planetary gear **24**, in a state where the planetary gear **24** can rotate and revolve. The small gear **27** is mounted on the carrier **26** on the surface side opposite to the planetary gear **24**. The large gear **28** is fixed to the output shaft **18** and is engaged with the small gear **27**. In this case, the auxiliary gear **43** mounted on the motor shaft **42** of the auxiliary motor **41** is a worm gear. The external teeth **25***b* of the annular gear **25** form a worm wheel.

Furthermore, the carrier **26** is held in a state where the carrier **26** is rotationally slid on the external circumference of the motor shaft **22** extending to the planetary gear **24**. In addition, the annular gear **25** is rotationally held by a third rolling bearing **35**, in a state where the annular gear **25** is located coaxially with a center axis of the main motor **15**.

The main motor **15** is a brushless motor using a permanent magnet. The main motor **15** is configured to have a rotor **30** and a stator **31**. The rotor **30** is rotationally supported. The stator **31** is located coaxially with a rotation center of the rotor **30**. The rotor **30** is press-fitted to the motor shaft **22**. A magnet **32** is fixed to the inner portion of the rotor **30**, using means for, for example, adhesion. In addition, the motor shaft **22** is rotationally held in a rear body **36**, through a first rolling bearing **33** and a second rolling bearing **34**. Furthermore, the rear body **36** and the front body **19** constitute the housing of the range change device **2**. The output shaft **18** of the range changing portion **17** and the axis center of the motor shaft **22** are located away from each other, and thus the small gear **27** and the large gear **28** can be disposed.

The control substrate **14** is fixed to the rear body **36**. One surface of the control substrate **14** is disposed facing the output shaft **18** of the range changing portion **17**. The other surface of the control substrate **14** is disposed at a position facing the rotor **30** of the main motor **15**.

Furthermore, a range change position detection sensor **37** which detects the rotation angle of the output shaft **18** is mounted on the control substrate **14**, at a position facing the output shaft **18**. In other words, the range change position detection sensor **37** is configured to have a magnetic flux orientation detection type magnetic sensor. In the control substrate **14**, the range change position detection sensor **37** is disposed at a position facing a magnet **38** embedded in the output shaft **18**, in the axis of the output shaft **18**. The range change position detection sensor **37** detects the rotation

position by detecting change in magnetic flux of the magnet **38** due to rotation of the output shaft **18**.

Furthermore, the stator **31** is configured to have a stator core **39** and a coil **40**. The stator core **39** forms a plurality of stator teeth extending in a radially inward direction. The coils **40** are connected in three phases of a U phase, a V phase, and a W phase, each of which is wound around each stator tooth.

In the range change device of the embodiment 1, which is configured as described above, the torque generated in the main motor **15** is reduced by the sun gear **23**, the planetary gear **24**, the annular gear **25**, and the carrier **26**, and then the torque is transmitted to the small gear **27**. The torque transmitted to the small gear **27** is reduced by the large gear **28** engaged with the small gear **27**, and then the torque is transmitted to the output shaft **18**. When the shift range is changed by the main motor **15**, the worm gear **43** connected to the auxiliary motor **41** is subjected to self-locking, in such a manner that the annular gear **25** is prevented from rotating. As a result, the auxiliary motor **41** is prevented from becoming a load of the main motor **15**.

Next, an operation for changing the shift range by the auxiliary motor **41** will be described. When it is determined that a shift-range change by the main motor **15** cannot be performed due to, for example, a reduction in voltage supplied to the range change device **2**, a shift-range change by the main motor **15** is switched to a shift-range change by the auxiliary motor **41**. In this case, at least any one phase of the phases of the coil **40** of the main motor **15** is subjected to excitation, the motor shaft **22** of the main motor **15** is prevented from rotating and, further, power is supplied to the auxiliary motor **41**. Here, the excitation in relation to the main motor **15** is DC excitation. Excitation with respect to the main motor **15** is started, and then power supply with respect to the auxiliary motor **41** is started. Accordingly, the coil **40** of the main motor **15** is subjected to excitation, and thus the motor shaft **22** moves to a fixed position corresponding to the excitation. Then, the rotation of the motor shaft **22** is prevented and rotation of the annular gear **25** by the auxiliary motor **41** is performed.

Accordingly, when the annular gear **25** is rotated by the auxiliary motor **41**, rotation of the planetary gear **24** is prevented by the motor shaft **22** of the main motor **15**, which is prevented from rotating. Therefore, the rotation of the annular gear **25** is transmitted to the carrier **26**, and thus the large gear **28** is driven. As a result, a shift-range change by the auxiliary motor **41** can be performed.

The main motor **15** requires responsiveness at large torque, and thus a large current type motor is used as the main motor **15**. However, when the supply voltage is equal to or less than a normal operation voltage, it is not possible to drive the main motor **15**. In contrast, a motor which has responsiveness inferior to that of the main motor **15** and can be driven even by voltage lower than operation voltage of the main motor **15** is used as the auxiliary motor **41**.

Furthermore, power may be supplied from a battery of a vehicle to the auxiliary motor **41** through a switch, such as a relay.

Furthermore, when it is determined that a shift-range change by the main motor **15** can be performed after the supply voltage is recovered to a normal state, the power supply to the auxiliary motor **41** is stopped. Accordingly, the rotation of the annular gear **25** is prevented again. Furthermore, the range position at which a shift-range change is performed by the auxiliary motor **41** can be switched to a range position at which a shift-range change is performed by the main motor **15**.

According to the range change device of the embodiment 1, the auxiliary motor is provided as described above. Accordingly, the following effects can be obtained. First, when supply voltage is reduced and it is difficult to perform a shift-range change by the main motor, one phase of the coil of the main motor is subjected to excitation and the auxiliary motor is driven, in such a manner that a shift-range change can be performed. In addition, when the supply voltage is recovered, the shift-range change by the auxiliary motor can return to the normal shift-range change by the main motor.

## Embodiment 2

FIG. **4** is a view illustrating a configuration of a coil portion of a main motor in a range change device according to an embodiment 2. A difference between the range change device of the embodiment 1 and the range change device of the embodiment 2 is the configuration of the coil portion of the main motor. Other configurations of the range change device of the embodiment 2 are the same as that of the embodiment 1. The description thereof will not be repeated.

A coil **44** different from the coil **40** for rotationally driving the main motor **15** is provided in a slot of the main motor **15**, which is the slot of the stator **31** of at least one phase. The coil **44** receives power through the common power supply system shared by the auxiliary motor **41**. Excitation of the coil **44** is started, and then power supply to the auxiliary motor **41** is started.

According to the embodiment described above, the power supply system in relation to the main motor **15** and the power supply system in relation to the auxiliary motor **41** are separated from each other. Thus, even when the power supply system in relation to the main motor **15** does not function due to some failure, such as disconnection in the coil of the main motor **15**, the coil **44** of which the common power supply system is shared by the auxiliary motor **41** is subjected to excitation, in such a manner that rotation of the motor shaft **22** of the main motor **15** is prevented. As a result, a shift-range change by the auxiliary motor **41** can be performed.

Furthermore, the power supply system in relation to the coil **44** and the auxiliary motor **41** are different from the power supply system in relation to the main motor **15**, and thus a shift-range change can be performed without being influenced by a type of failure generated in the main motor **15**.

In the description of the embodiment 2, the coil **44** is wound around the stator core **39** of the main motor **15**, in a state where the coil **44** overlaps a coil of one phase. However, the configuration is not limited thereto. The coil **44** may be wound over the coil of any two phases. The effect of the present invention can be obtained as long as the configuration in which rotation of the motor shaft **22** is prevented is adopted.

According to the range change device of the embodiment 2, the auxiliary motor is provided as described above. Accordingly, the following effects can be obtained. First, when it is difficult to perform a shift-range change by the main motor due to a power supply stop or a reduction in supply voltage, a coil for excitation which is provided in the main motor, in addition to a coil for a normal purpose is subjected to excitation, and the auxiliary motor is driven, in such a manner that a shift-range change can be performed. In addition, when the supply voltage is recovered, the shift-range change by the auxiliary motor can return to the normal shift-range change by the main motor.

In the description of the embodiments, a shift-range change at the time of a reduction in supply voltage is performed by a motor. However, the configuration is not limited thereto. A shift-range change at the time of a reduction in supply voltage may be performed by an electromagnetic solenoid which performs a rotational operation as output.

Various modifications and alterations of this invention will be apparent to those skilled in the art without departing from the scope and spirit of this invention, and it should be understand that this is not limited to the illustrative embodiments set forth herein.

What is claimed is:

**1**. A range change device comprising:

a main motor and an auxiliary motor;

a sun gear which is joined to a motor shaft of the main motor;

an auxiliary gear which is joined to a motor shaft of the auxiliary motor;

a plurality of planetary gears which are engaged with the sun gear and are arranged on a circumference of the sun gear at equal intervals;

an annular gear in which internal teeth engaged with the planetary gears and external teeth engaged with the auxiliary gear are formed;

a carrier which supports the planetary gears in a state where the carrier allows the planetary gears to rotate and revolve and is held in a state where the carrier is rotationally slid on an external circumference of the motor shaft of the main motor;

a small gear which is mounted on the carrier on a surface opposite to a surface on which the planetary gears are mounted and rotates about an axis of the motor shaft of the main motor; and

a large gear which is engaged with the small gear,

wherein a shift range of an automatic transmission is changed by rotation of the large gear.

**2**. The range change device according to claim **1**,

wherein the auxiliary gear is a worm gear and the external teeth of the annular gear form a worm wheel.

**3**. The range change device according to claim **1**,

wherein the main motor includes a conductor to perform DC excitation.

**4**. The range change device according to claim **3**,

wherein a power supply system in relation to the conductor and the auxiliary motor is different from a power supply system in relation to the main motor.

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